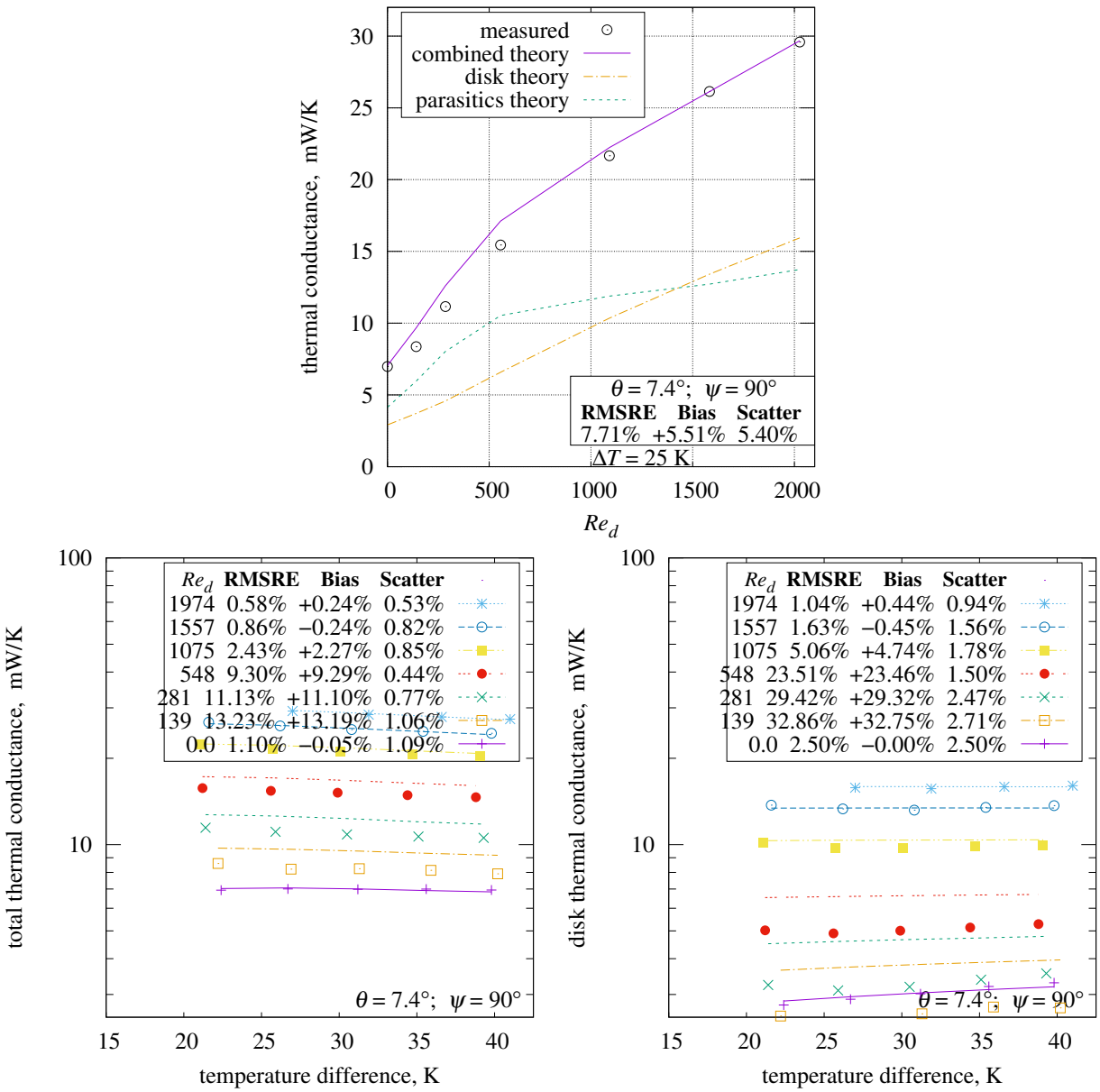
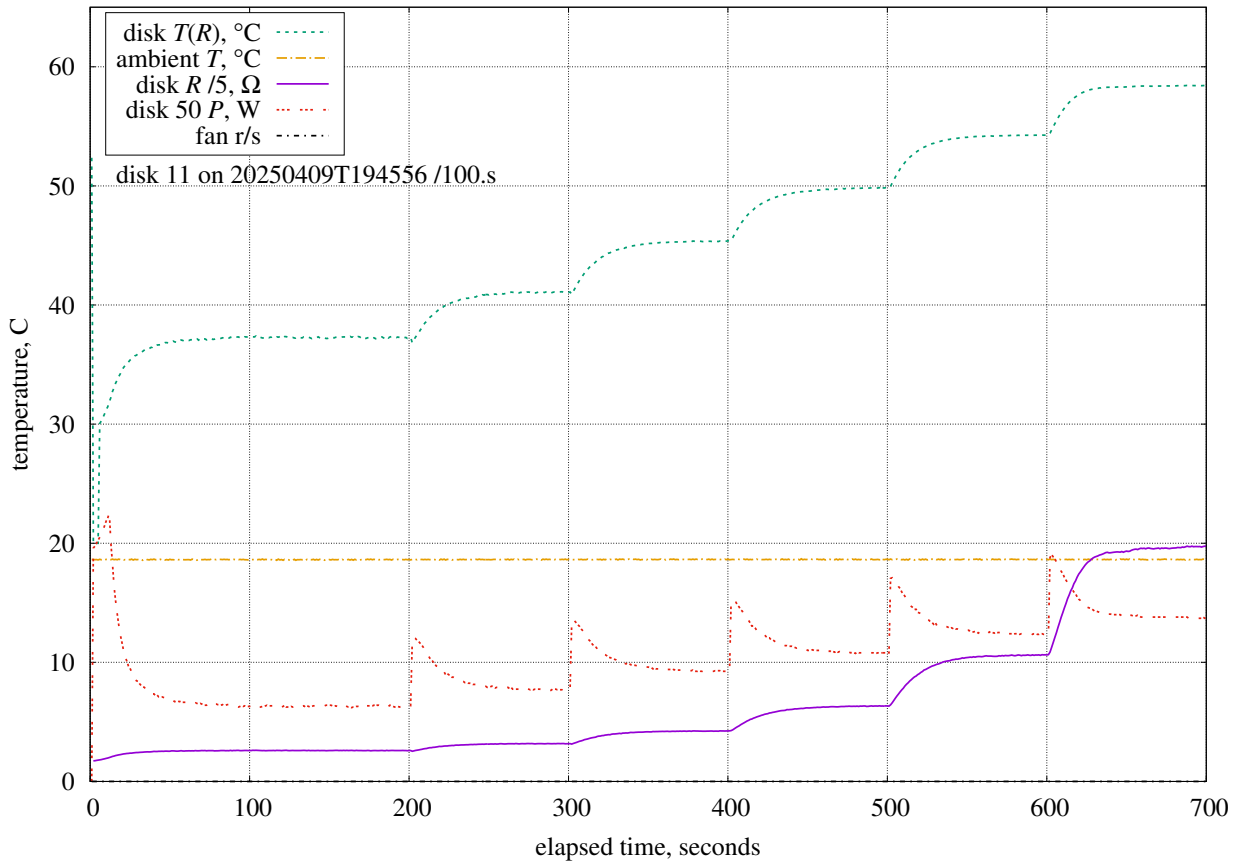
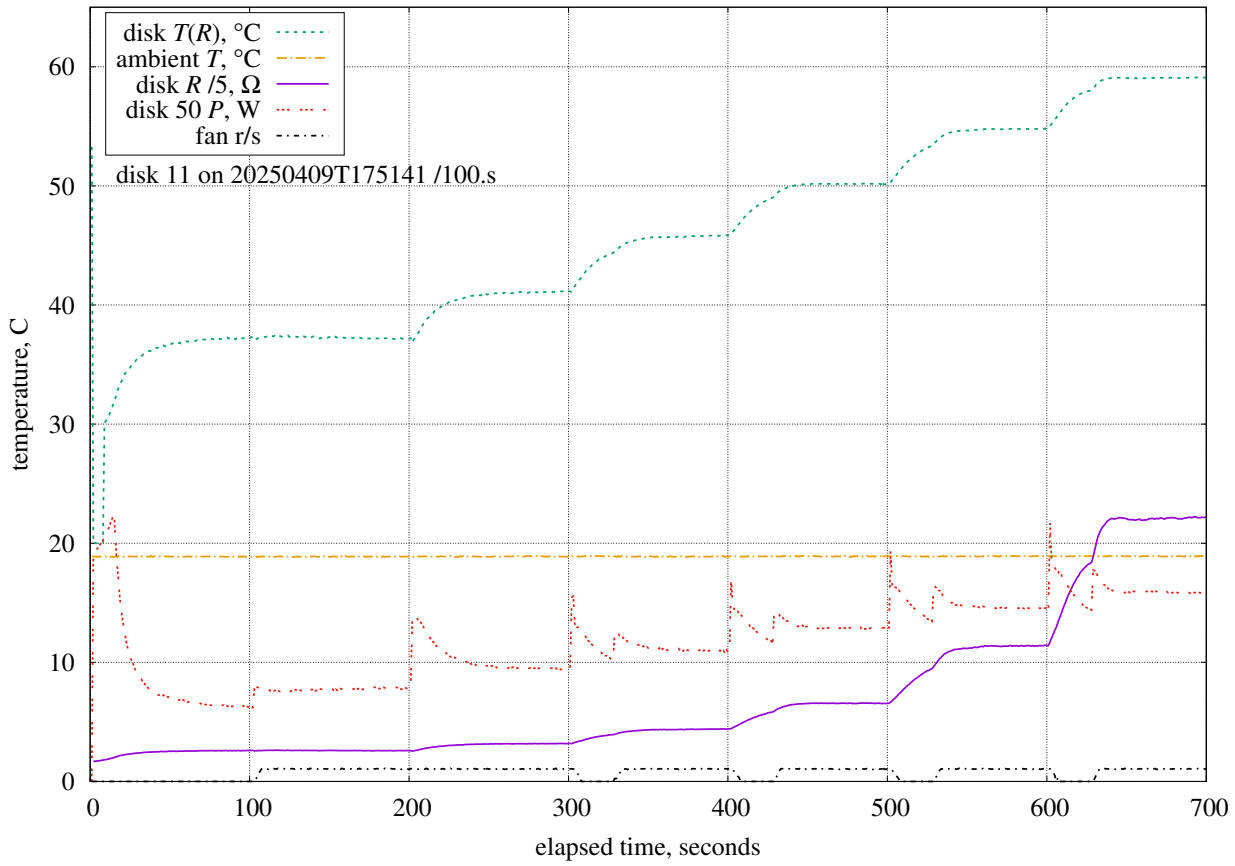

measured
combined theory
disk theory
parasitics theory
thermal conductance, mW/K
Re_d
$\theta = 7.4°$; $\psi = 90°$
RMSRE Bias Scatter
7.71% +5.51% 5.40%
$\Delta T = 25$ K
Re_d RMSRE Bias Scatter
1974 0.58% +0.24% 0.53%
1557 0.86% −0.24% 0.82%
1075 2.43% +2.27% 0.85%
548 9.30% +9.29% 0.44%
281 11.13% +11.10% 0.77%
139 13.23% +13.19% 1.06%
0.0 1.10% −0.05% 1.09%
total thermal conductance, mW/K
temperature difference, K
Re_d RMSRE Bias Scatter
1974 1.04% +0.44% 0.94%
1557 1.63% −0.45% 1.56%
1075 5.06% +4.74% 1.78%
548 23.51% +23.46% 1.50%
281 29.42% +29.32% 2.47%
139 32.86% +32.75% 2.71%
0.0 2.50% −0.00% 2.50%
disk thermal conductance, mW/K
temperature difference, K



$\theta = 7.4°;\ \psi = 90.0°;\ V = 0.000$ **m/s (0 r/min)**

Estimated measurement uncertainties of natural convection at $\theta = 7.4$.

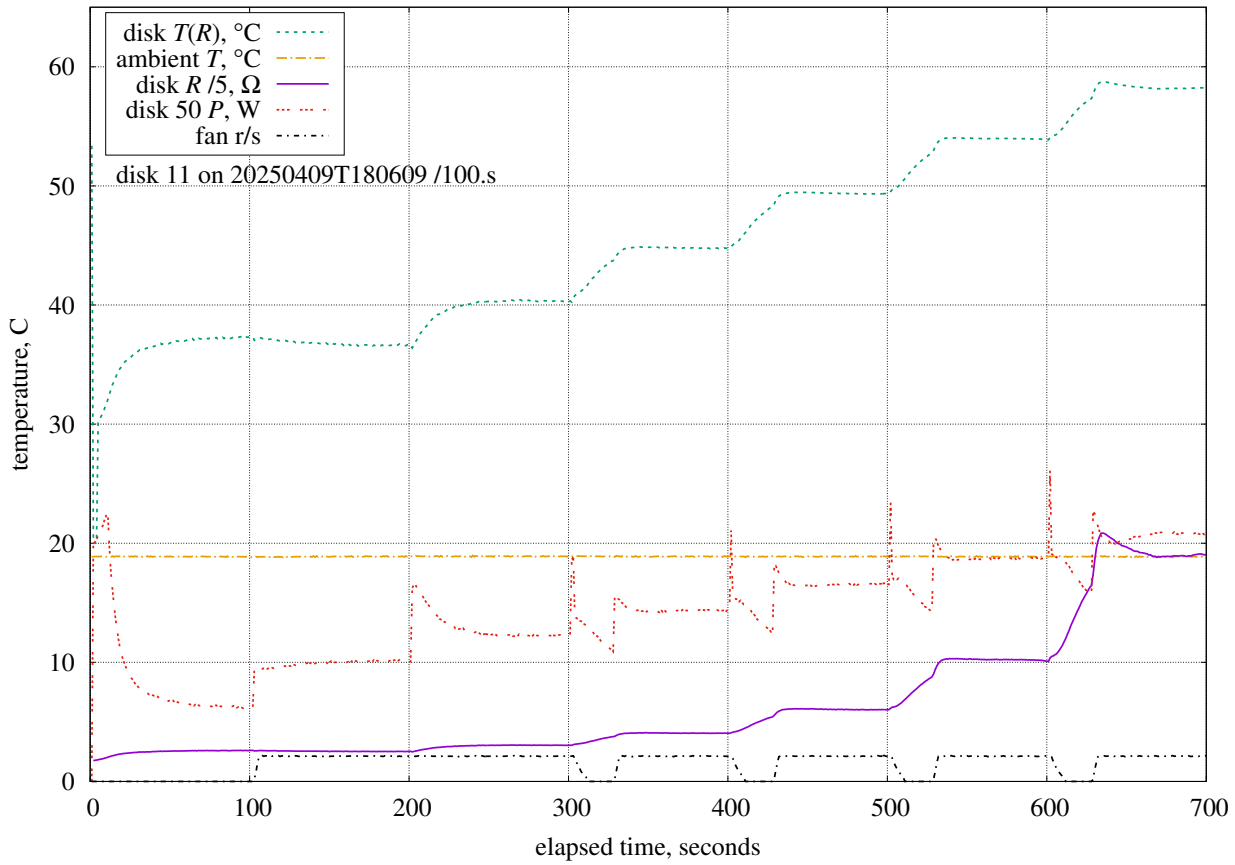
Symbol	Nominal	Sensitivity	Bias	Uncertainty	Component
ΔT	25.0.K	+4.35%/K	0.10.K	0.43%	LM35C differential
P	101.kPa	+0.0002%/Pa	1.5.kPa	0.23%	MPXH6115A6U air pressure
D_o	2.81.mm	+3268%/m	500.um	1.63%	tube outer diameter
D_i	1.11.mm	+5119%/m	200.um	1.02%	tube inner diameter
D_g	166.um	−273%/m	750.um	0.21%	tube air gap
L_{wire}	38.0.mm	+1139%/m	500.um	0.57%	wire length
k_{ABS}	179.$\frac{\text{mW}}{\text{K·m}}$	+0.134%/$\frac{\text{mW}}{\text{K·m}}$	9.0.$\frac{\text{mW}}{\text{K·m}}$	1.20%	ABS thermal conductivity
d	12.0.mm	+4033%/m	100.um	0.40%	disk diameter
				2.44%	combined bias uncertainty



$\theta = 7.4°;\ \psi = 90.0°;\ V = 0.190$ **m/s (63 r/min)**

Estimated measurement uncertainties at $Re = 141$**.**

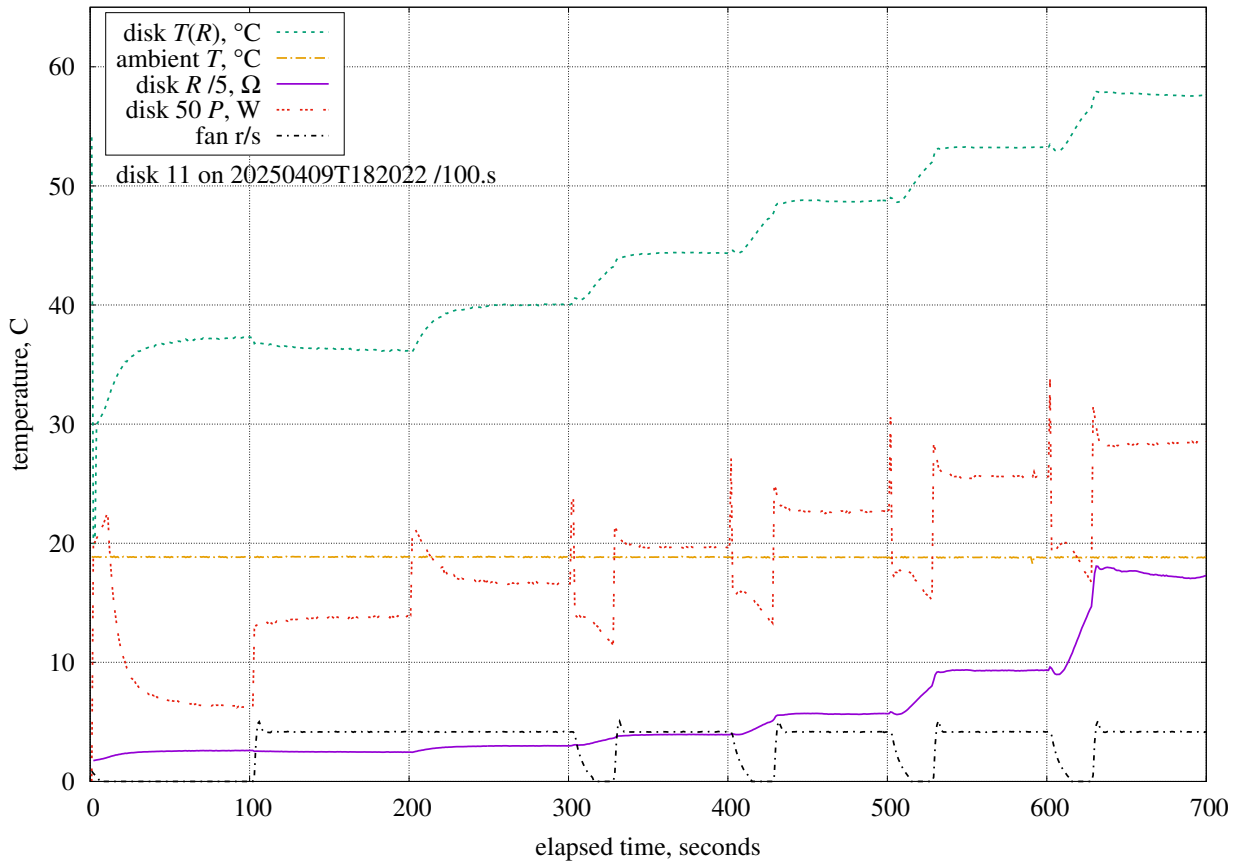
Symbol	Nominal	Sensitivity	Bias	Uncertainty	Component
ΔT	25.0.K	+4.14%/K	0.10.K	0.41%	LM35C differential
P	101.kPa	+0.0003%/Pa	1.5.kPa	0.42%	MPXH6115A6U air pressure
η	0.340	+66.4%	0.007	0.45%	anemometer calibration
Re_0	600	−0.0046%	60	0.28%	integration lower-bound
D_o	2.81.mm	+638%/m	500.um	0.32%	tube outer diameter
D_i	1.11.mm	+7641%/m	200.um	1.53%	tube inner diameter
D_g	166.um	−369%/m	750.um	0.28%	tube air gap
L_{wire}	38.0.mm	+1537%/m	500.um	0.77%	wire length
k_{ABS}	179.$\frac{\text{mW}}{\text{K·m}}$	+0.154%/$\frac{\text{mW}}{\text{K·m}}$	9.0.$\frac{\text{mW}}{\text{K·m}}$	1.38%	ABS thermal conductivity
d	12.0.mm	+4219%/m	100.um	0.42%	disk diameter
				2.41%	combined bias uncertainty
Symbol	**Nominal**	**Sensitivity**	**Variability**	**Uncertainty**	**Component**
ω	63.1.r/min	+0.358%/(r/min)	1.4.r/min	0.49%	fan rotation rate
				2.60%	RSS combined uncertainty



$\theta = 7.4°$; $\psi = 90.0°$; $V = 0.383$ **m/s (127 r/min)**

Estimated measurement uncertainties at $Re = 285$**.**

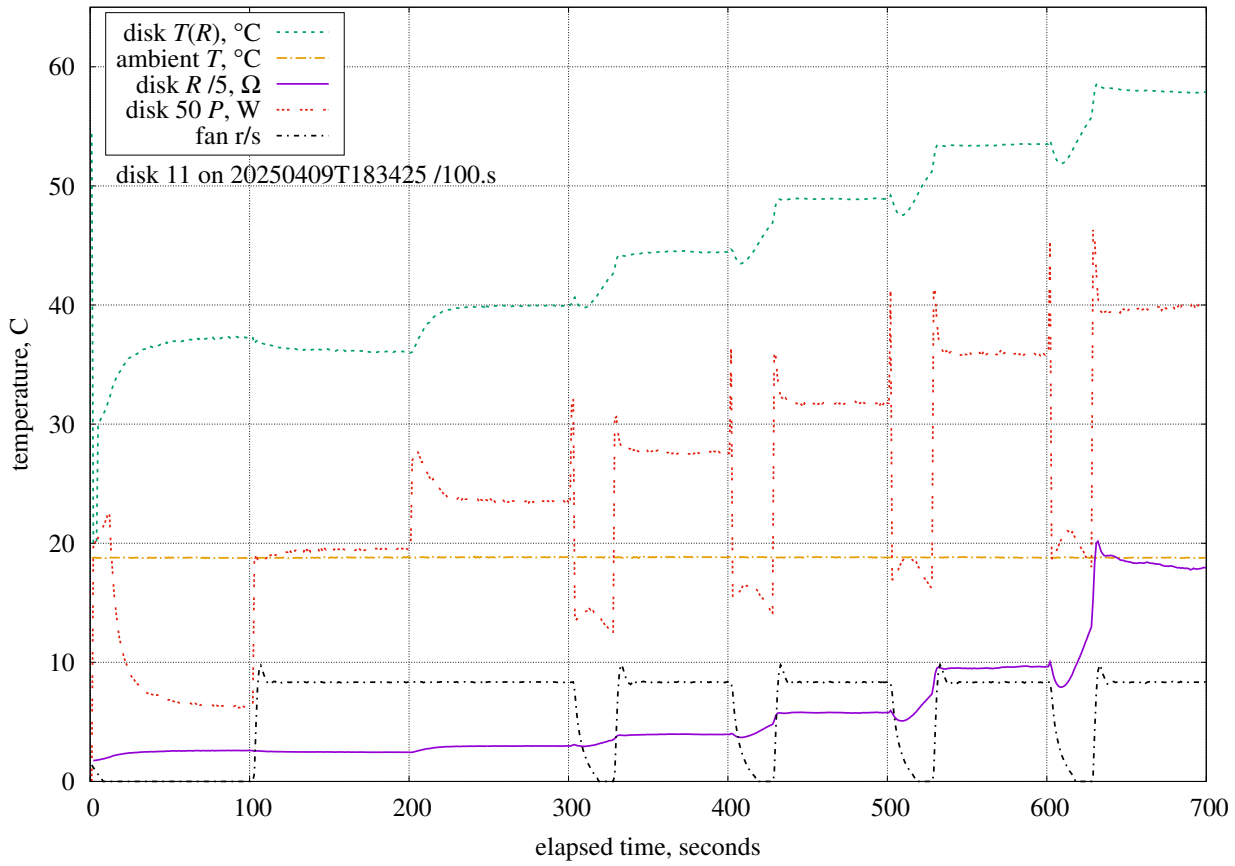
Symbol	Nominal	Sensitivity	Bias	Uncertainty	Component
ΔT	25.0.K	+4.08%/K	0.10.K	0.41%	LM35C differential
P	101.kPa	+0.0005%/Pa	1.5.kPa	0.78%	MPXH6115A6U air pressure
η	0.340	+148%	0.007	1.00%	anemometer calibration
Re_0	600	−0.0066%	60	0.40%	integration lower-bound
D_o	2.81.mm	+5084%/m	500.um	2.54%	tube outer diameter
D_i	1.11.mm	+11196%/m	200.um	2.24%	tube inner diameter
D_g	166.um	−483%/m	750.um	0.36%	tube air gap
L_{wire}	38.0.mm	+2011%/m	500.um	1.01%	wire length
k_{ABS}	179.$\frac{\text{mW}}{\text{K·m}}$	+0.175%/$\frac{\text{mW}}{\text{K·m}}$	9.0.$\frac{\text{mW}}{\text{K·m}}$	1.57%	ABS thermal conductivity
d	12.0.mm	+4433%/m	100.um	0.44%	disk diameter
				4.15%	combined bias uncertainty
Symbol	**Nominal**	**Sensitivity**	**Variability**	**Uncertainty**	**Component**
ω	127.r/min	+0.394%/(r/min)	1.1.r/min	0.45%	fan rotation rate
				4.25%	RSS combined uncertainty



$\theta = 7.4°$; $\psi = 90.0°$; $V = 0.748$ **m/s (250 r/min)**

Estimated measurement uncertainties at $Re = 556$**.**

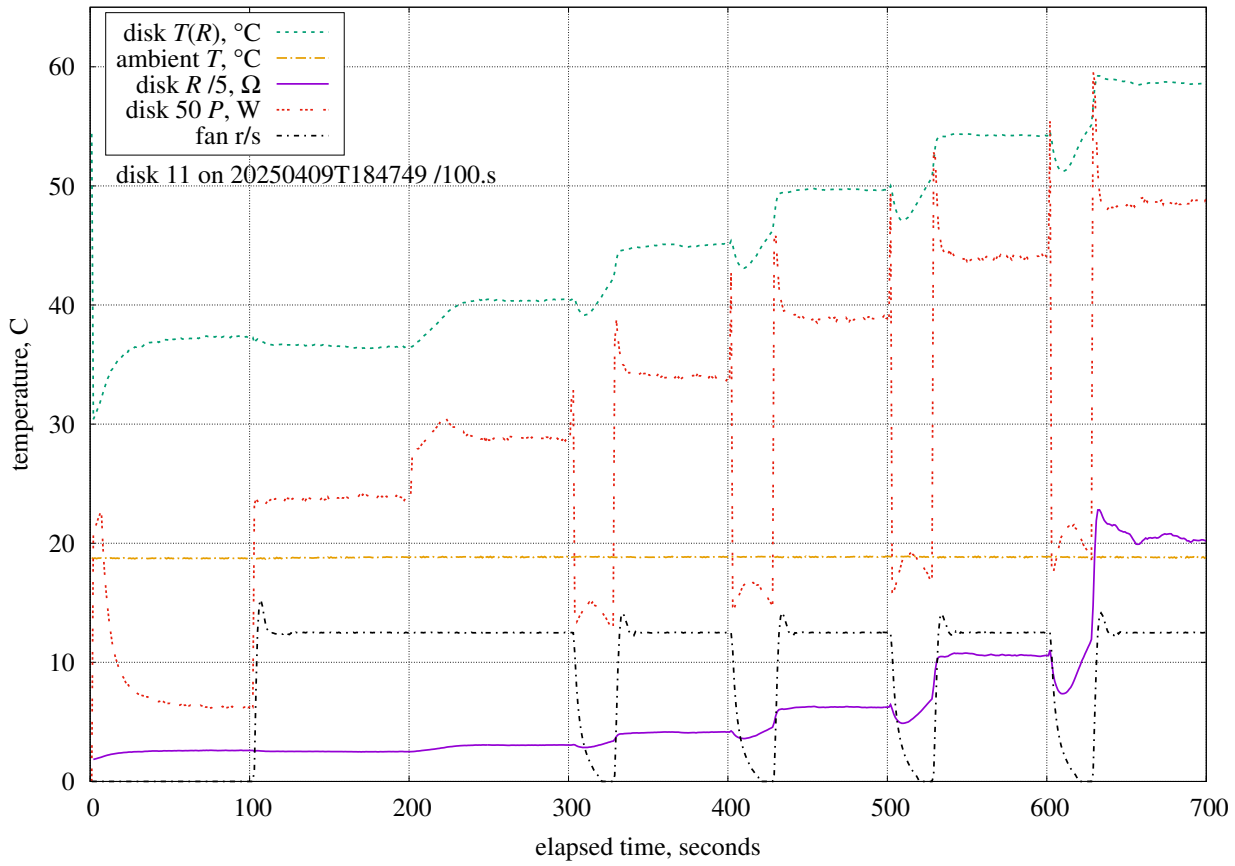
Symbol	Nominal	Sensitivity	Bias	Uncertainty	Component
ΔT	25.0.K	+4.04%/K	0.10.K	0.40%	LM35C differential
P	101.kPa	+0.0004%/Pa	1.5.kPa	0.54%	MPXH6115A6U air pressure
η	0.340	+105%	0.007	0.71%	anemometer calibration
Re_0	600	−0.0077%	60	0.46%	integration lower-bound
C_B	0.541	+4.88%	0.100	0.49%	bypass coefficient
D_o	2.81.mm	−5180%/m	500.um	2.59%	tube outer diameter
D_i	1.11.mm	+14414%/m	200.um	2.88%	tube inner diameter
D_g	166.um	−587%/m	750.um	0.44%	tube air gap
L_{wire}	38.0.mm	+2448%/m	500.um	1.22%	wire length
k_{ABS}	179. $\frac{\text{mW}}{\text{K·m}}$	+0.186%/$\frac{\text{mW}}{\text{K·m}}$	9.0. $\frac{\text{mW}}{\text{K·m}}$	1.67%	ABS thermal conductivity
d	12.0.mm	+5290%/m	100.um	0.53%	disk diameter
				4.61%	combined bias uncertainty
Symbol	**Nominal**	**Sensitivity**	**Variability**	**Uncertainty**	**Component**
ω	250.r/min	+0.143%/(r/min)	1.2.r/min	0.18%	fan rotation rate
				4.62%	RSS combined uncertainty



$\theta = 7.4°$; $\psi = 90.0°$; $V = 1.467$ **m/s (500 r/min)**

Estimated measurement uncertainties at $Re = 1091$**.**

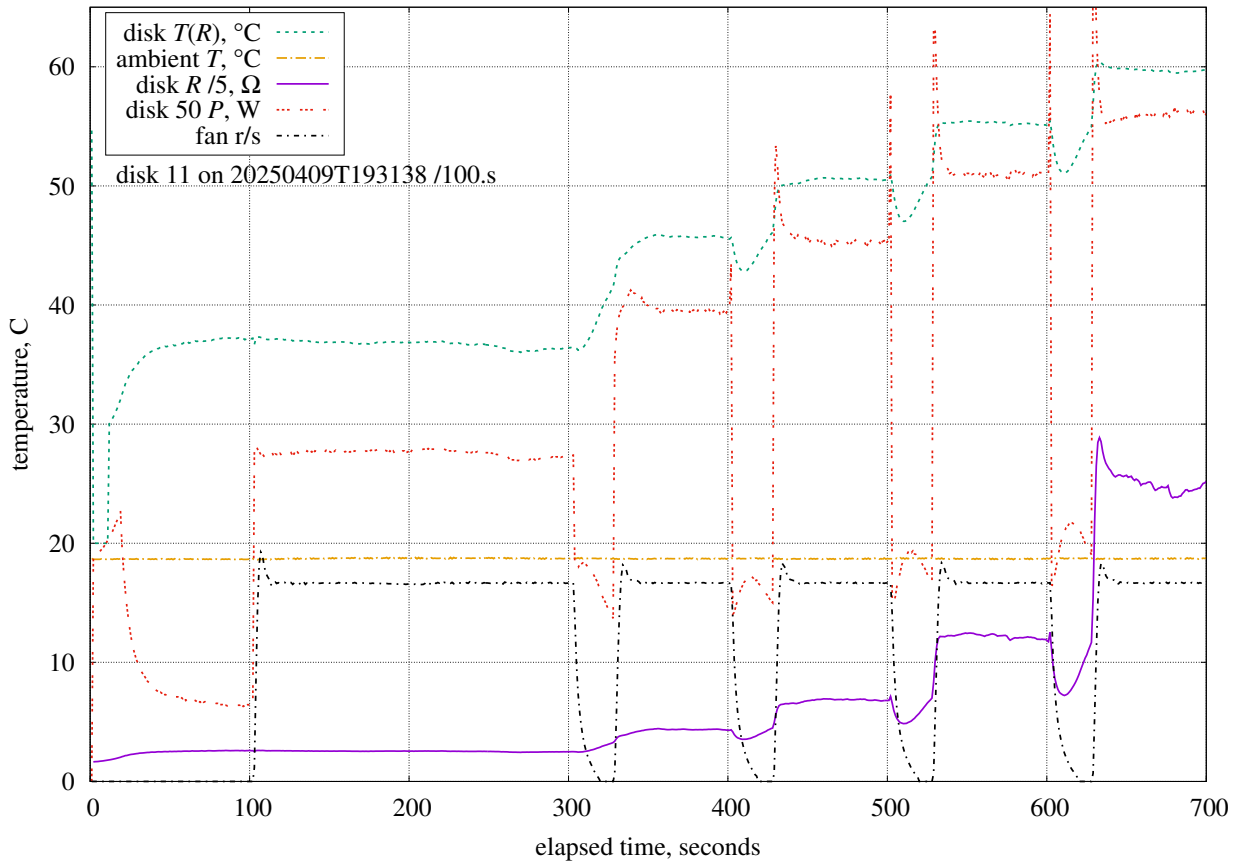
Symbol	Nominal	Sensitivity	Bias	Uncertainty	Component
ΔT	25.0.K	+4.02%/K	0.10.K	0.40%	LM35C differential
P	101.kPa	+0.0003%/Pa	1.5.kPa	0.46%	MPXH6115A6U air pressure
η	0.340	+89.9%	0.007	0.61%	anemometer calibration
Re_0	600	−0.0087%	60	0.52%	integration lower-bound
C_B	0.541	+7.23%	0.100	0.72%	bypass coefficient
D_o	2.81.mm	−9031%/m	500.um	4.52%	tube outer diameter
D_i	1.11.mm	+12922%/m	200.um	2.58%	tube inner diameter
D_g	166.um	−577%/m	750.um	0.43%	tube air gap
L_{wire}	38.0.mm	+2404%/m	500.um	1.20%	wire length
k_{ABS}	179.$\frac{\text{mW}}{\text{K·m}}$	+0.163%/$\frac{\text{mW}}{\text{K·m}}$	9.0.$\frac{\text{mW}}{\text{K·m}}$	1.46%	ABS thermal conductivity
d	12.0.mm	+6539%/m	100.um	0.65%	disk diameter
				5.73%	combined bias uncertainty
Symbol	**Nominal**	**Sensitivity**	**Variability**	**Uncertainty**	**Component**
ω	500.r/min	+0.061%/(r/min)	1.7.r/min	0.10%	fan rotation rate
				5.73%	RSS combined uncertainty



$\theta = 7.4°$; $\psi = 90.0°$; $V = 2.130$ **m/s (750 r/min)**

Estimated measurement uncertainties at $Re = 1583$**.**

Symbol	Nominal	Sensitivity	Bias	Uncertainty	Component
ΔT	25.0.K	+4.01%/K	0.10.K	0.40%	LM35C differential
P	101.kPa	+0.0004%/Pa	1.5.kPa	0.63%	MPXH6115A6U air pressure
η	0.340	+117%	0.007	0.80%	anemometer calibration
Re_0	600	−0.0088%	60	0.53%	integration lower-bound
C_B	0.541	+8.38%	0.100	0.84%	bypass coefficient
D_o	2.81.mm	−5649%/m	500.um	2.82%	tube outer diameter
D_i	1.11.mm	+11943%/m	200.um	2.39%	tube inner diameter
D_g	166.um	−566%/m	750.um	0.42%	tube air gap
L_{wire}	38.0.mm	+2358%/m	500.um	1.18%	wire length
k_{ABS}	179.$\frac{\text{mW}}{\text{K·m}}$	+0.150%/$\frac{\text{mW}}{\text{K·m}}$	9.0.$\frac{\text{mW}}{\text{K·m}}$	1.34%	ABS thermal conductivity
d	12.0.mm	+7220%/m	100.um	0.72%	disk diameter
				4.45%	combined bias uncertainty
Symbol	**Nominal**	**Sensitivity**	**Variability**	**Uncertainty**	**Component**
ω	750.r/min	+0.053%/(r/min)	0.79.r/min	0.04%	fan rotation rate
				4.45%	RSS combined uncertainty



$\theta = 7.4°$; $\psi = 90.0°$; $V = 2.725$ **m/s (1000 r/min)**

Estimated measurement uncertainties at $Re = 2026$**.**

Symbol	Nominal	Sensitivity	Bias	Uncertainty	Component
ΔT	25.0.K	+4.01%/K	0.10.K	0.40%	LM35C differential
P	101.kPa	+0.0004%/Pa	1.5.kPa	0.66%	MPXH6115A6U air pressure
η	0.340	+112%	0.007	0.76%	anemometer calibration
Re_0	600	−0.0087%	60	0.52%	integration lower-bound
C_B	0.541	+8.98%	0.100	0.90%	bypass coefficient
D_o	2.81.mm	−5377%/m	500.um	2.69%	tube outer diameter
D_i	1.11.mm	+11823%/m	200.um	2.36%	tube inner diameter
D_g	166.um	−579%/m	750.um	0.43%	tube air gap
L_{wire}	38.0.mm	+2411%/m	500.um	1.21%	wire length
k_{ABS}	179. $\frac{\text{mW}}{\text{K·m}}$	+0.144%/$\frac{\text{mW}}{\text{K·m}}$	9.0. $\frac{\text{mW}}{\text{K·m}}$	1.29%	ABS thermal conductivity
d	12.0.mm	+7549%/m	100.um	0.75%	disk diameter
				4.36%	combined bias uncertainty
Symbol	**Nominal**	**Sensitivity**	**Variability**	**Uncertainty**	**Component**
ω	1000.r/min	+0.038%/(r/min)	1.8.r/min	0.07%	fan rotation rate
				4.36%	RSS combined uncertainty